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U. S. ARMY AEROMEDICAL RESEARCH LABORATORY

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SUMMARY PAGE

THE PROBLEM

A Brief Vestibular Disorientation Test (BVDT) was developed that involves observer assessment of subjects' reactions produced by head movements in a rotating chair. Reliability of measurement has been demonstrated, and significant validation and cross-validation coefficients have been reported for criteria of pass versus various types of separations from pilot training. It has also been established that the BVDT score significantly augmented the multiple correlation of existing aviation selection variables with the same criteria. The purpose of this study was to determine if reliability, validity, and augmentation of correlation could be obtained with less disturbance to the subject than that caused by the 15-rpm speed of rotation used thus far in the BVDT. Reduced disturbance and aftereffects are desired because the BVDT is now envisioned as becoming part of the entering flight physical, and procedures that might either impair performance on the other tests or require recovery periods must be held to a minimum. The BVDT procedure used here was identical to two previous studies except that a speed of 10 rpm was used instead of 15 rpm.

FINDINGS

The test-retest and rater reliability coefficients obtained for this group were not quite so high as for those who had the 15-rpm procedure, but they were of acceptable magnitude. The validity coefficients were approximately the same as those obtained for 15 rpm, and significant augmentation of the existing selection battery and cost effectiveness was demonstrated. It was concluded, therefore, that the 10-rpm BVDT was a feasible procedure. It was also concluded that, because the mean score for the 10-rpm group was lower than the mean for either of the two 15-rpm groups used previously, subject disturbance had been reduced.

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INTRODUCTION

The Coriolis vestibular reaction, which can be elicited by tilting the head during simple whole-body rotation, has been of interest to the aviation examiner since the time of World War I. Early attention centered mainly around identifying and describing the phenomenon. More recently, efforts have been made to assess the subject's total behavior associated with the Coriolis vestibular reaction and to correlate these assessments with some external criterion (1-7). Evaluations of individuals experiencing this Coriolis vestibular reaction have been compared with regard to subsequent performance in flight training in the Netherlands (6) and Canadian (7) Air Training Commands. Results were encouraging in that the evaluations appeared to predict success and also occurrence of motion sickness in flight training. Performance on tests in a rotating environment also has been found to be predictive of susceptibility to airsickness and seasickness (5).

At Pensacola a Brief Vestibular Disorientation Test (BVDT) has been developed that involves observer assessments of subjects' reactions produced by head movements in a rotating chair. A structured rating procedure for observer use was introduced to permit brief and objective administration of the test by personnel who have only a modicum of training for the task (4). Agreement among observers from a variety of backgrounds has been demonstrated, and significant validation and cross-validation coefficients have been reported for criteria of pass versus various types of separations from pilot training (1, 2). It has also been established that the BVDT score significantly augmented the multiple correlation of existing aviation selection variables with the same criteria (1, 2). The purpose of the present study was to determine if reliability, validity, and augmentation of correlation could be obtained with less disturbance to the subject than that caused by the 15-rpm speed of rotation used thus far in the BVDT. Reduced disturbance and aftereffects are desired because the BVDT is now envisioned as becoming part of the entering flight physical, and procedures that might either impair performance on other tests or require recovery periods must be held to a minimum.

PROCEDURE

Subjects were 157 flight students who were tested within the first four days of reporting for aviation training. Retesting was conducted for 72 of the subjects after nine weeks of the eleven-week Aviation Officer Candidate School course which preceded actual flight training. The BVD test procedure used here was identical to that of two previous studies except that a 10-rpm speed of rotation was used instead of 15 rpm. With the motorized rotary chair stationary, each subject was asked to practice slow lateral head movements of 45° with his eyes closed and without mechanical aids. After instructions were given, the chair was accelerated to a constant velocity of 60°/sec (10 rpm). After 30 sec of constant speed rotation the following head positions were assumed: right, upright, left, upright, right, upright, left, upright, forward, upright. Each position was maintained for 30 sec; thirty seconds after the last upright head position was assumed, the chair was stopped. The subject was instructed to open his eyes after sensation of movement stopped. Three observers made independent ratings of each subject during the sequence. Rater estimates of pallor, sweating, facial expression, unsteadiness, speed of

recovery, and over-all performance were recorded on a ten-point scale. The low point on the scale represented low sensitivity, or no effect. An individual rater's score was obtained simply by summing his judgments on the six factors. The BVDT score for a given subject was the mean of these three individual ratings. From six to ten subjects were tested during a given weekly test session. Six different individuals served as raters during the course of the experiment.

Raters were told not to make relative judgments of subjects but to judge each man separately. For example, a rating of 10 on sweating would mean that the man was sweating as profusely as possible. This procedure was adopted to avoid, if possible, the necessity of giving raters a wealth of experience in comparing subjects before they could qualify to administer the test and to avoid having the individual's rating reflect his standing within his subgroup rather than his standing within the student population.

After rotation each subject was asked to rate on a seven-point scale certain of his reactions to the experience. This questionnaire included five specific areas of reaction: like/dislike, no stomach effects/strong stomach effects, no dizziness/strong dizziness, no sickness feelings/strong sickness feelings, and steady on feet/very unsteady on feet. A mark of 1 on the scale indicated favorable or no reaction, and a mark of 7 indicated extreme reaction; therefore, it was possible to have a range of scores from 5 to 35.

ANALYSIS AND RESULTS

Table I presents the test-retest reliability for the 72 subjects compared with those previously retested in the second of the two 15-rpm groups. The coefficients reported for Single Independent Rater were computed by correlating the ratings assigned by one rater in the first test session with those of a different rater in the retest session. The retest rater was not present during the first session. These independent ratings were available for 43 of the retested subjects. The 10-rpm reliability coefficients were of acceptable magnitude although the 15-rpm values were superior.

As in earlier validation studies, the BVD test scores were correlated with the dichotomous criteria of separation versus completion of pilot training, and separation for tension versus all other causes. The airsick separations versus the "all others" dichotomy was not used for the 10-rpm data because only two airsick separations have occurred in this sample. Table II contains the point biserial correlations for the three study groups and the different criteria. In terms of the magnitude of the correlations, the 10-rpm group compared favorably with the 15-rpm groups; however, the smaller N value of the 10-rpm group resulted in slightly reduced significance levels.

The next consideration was whether or not the 10-rpm BVDT augmented the existing primary selection variables; that is, the Aviation Qualification Test, the Mechanical Comprehension Test, the Spatial Apperception Test, and the Biographical Inventory. Table III shows the multiple correlations of the selection tests and the BVDT with the two dichotomous criteria. For both of these criteria the BVDT significantly augmented the selection battery.

Table I

Test-Retest Reliability for BVDT at 10 rpm Compared to 15 rpm

Condition	r (15 rpm Group 2)	N	r (10 rpm Group 3)	N
BVD score	.83*	30**	.70*	72**
Single independent rater	.69*	30**	.60*	43**

*r significant at less than .01 level
** Only portions of the total number of subjects were available for retesting.

Table II

Correlations of BVDT Scores with Four Dichotomous Criteria

Criterion	Group 1: 15 rpm (N=226)	Group 2: 15 rpm (N=239)	Group 3: 10 rpm (N=157)
Separations (all causes) vs. completions	.165**	.141**	.142*
Tension separations vs. all others	.085	.234****	.234***
Airsick separations vs. all others	.391****	.184***	--#
Tension and/or airsick separations vs. all others	.267****	.223****	.234***

*p< .10 **p< .05 ***p< .01 ****p< .001
Only two airsick separations have occurred

Table IV contains the over-all mean and standard deviation for the BVDT 10-rpm group compared to those for the 15-rpm groups. The 10-rpm group had a significantly lower mean than either of the 15-rpm groups. These differences were significant at less than the .001 level for Group 1 and at less than the .05 level for Group 2. Table IV also contains comparative means and standard deviations for the Self-Rate scores, or subjects' stated reactions. Here the 10-rpm group was also lower than both 15-rpm groups, but the difference was significant for the cross-validation group (Group 2) and not for the first study group. In general, these results in Table IV supported the expected outcome; namely, that the 10-rpm procedure would be less disturbing to the subject than the 15-rpm one. It was decided, however, to examine more closely the data from the two mean comparisons that were not significantly different; i.e., the data from Group I and the 10-rpm group.

As noted earlier, this Self-Rate consisted of five specific areas of reaction, each of which was rated on a seven-point scale. One of these five areas was purely attitudinal; that is, like/dislike. The remaining four could be described as dealing with symptomatology; i.e., stomach effects, dizziness, sickness, and steadiness on feet. Inspection of the percentage distributions of responses along the seven-point scale for each of the five areas revealed an interesting difference between the 10-rpm group and the 15-rpm group of the first study. The 10-rpm group tended to express greater dislike (poorer attitude) for the experience than did that 15-rpm group, but this same 10-rpm group reported unfavorable symptoms to a lesser degree than did the 15-rpm one. Figure 1 displays this observation. According to expectations, the cumulative percentage plot of symptoms across the seven-point scale shows fewer cases at the favorable end of the response scale for the 15-rpm group than for the 10-rpm group. The reverse occurred for the attitude curves. The significance of the differences between the frequency distributions from which these curves were derived was tested by the chi-square statistic. Both comparisons were significantly different at less than the .001 level. A rationalization for this finding requires a departure from a psychophysiological approach for a moment. About five years separated the acquisition of data from the 15-rpm Group 1 and the 10-rpm studies. Human physiology did not change during that period, but the attitudes of young people did. It is possible that the results were, albeit in a minimal way, a reflection of some of the effects of the protest movement. This is something to keep in mind in current psychophysiological research, especially where attitudinal correlates are involved.

The practicality of the BVDT as a predictor is illustrated in Table V which shows the interaction between the BVDT and the Flight Aptitude Rating (FAR). If all students below the broken line had been rejected, a group that had over twice the attrition rate of the remainder of the group would have been eliminated (52.3 per cent vs 24.5 per cent). Stated more conservatively, the over-all attrition rate for this group would have been reduced from 26.5 per cent to 24.5 per cent. In a 2000-men per year input situation this would mean 40 individuals at a savings of about $30,000* per case, or $1,200,000.00 per annum. The BVDT would cost from $50,000 to $60,000 to implement; therefore, the net savings effected would be $1,140,000.

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*Estimated expenditure for average flight attrition case.

Table III

Shrunken Predictive Validities for Two Criteria for 10 rpm BVDT

Criterion	Current Predictors	Augmented by BVDT
Separations (all causes) vs completions	.158	.206
Tension separations vs all others	.141	.271

Table IV

Over-all Mean BVDT Scores and Self-Rate Scores Compared for 15-rpm and 10-rpm Conditions

		BVDT	Self-Rate
Group 1: 15 rpm (N = 226)	$\bar{x}$	12.64	10.83
	σ	5.76	5.28
Group 2: 15 rpm (N = 239)	$\bar{x}$	14.23	12.02
	σ	6.46	5.75
Group 3: 10 rpm (N = 157)	$\bar{x}$	11.33	10.20
	σ	5.11	5.02

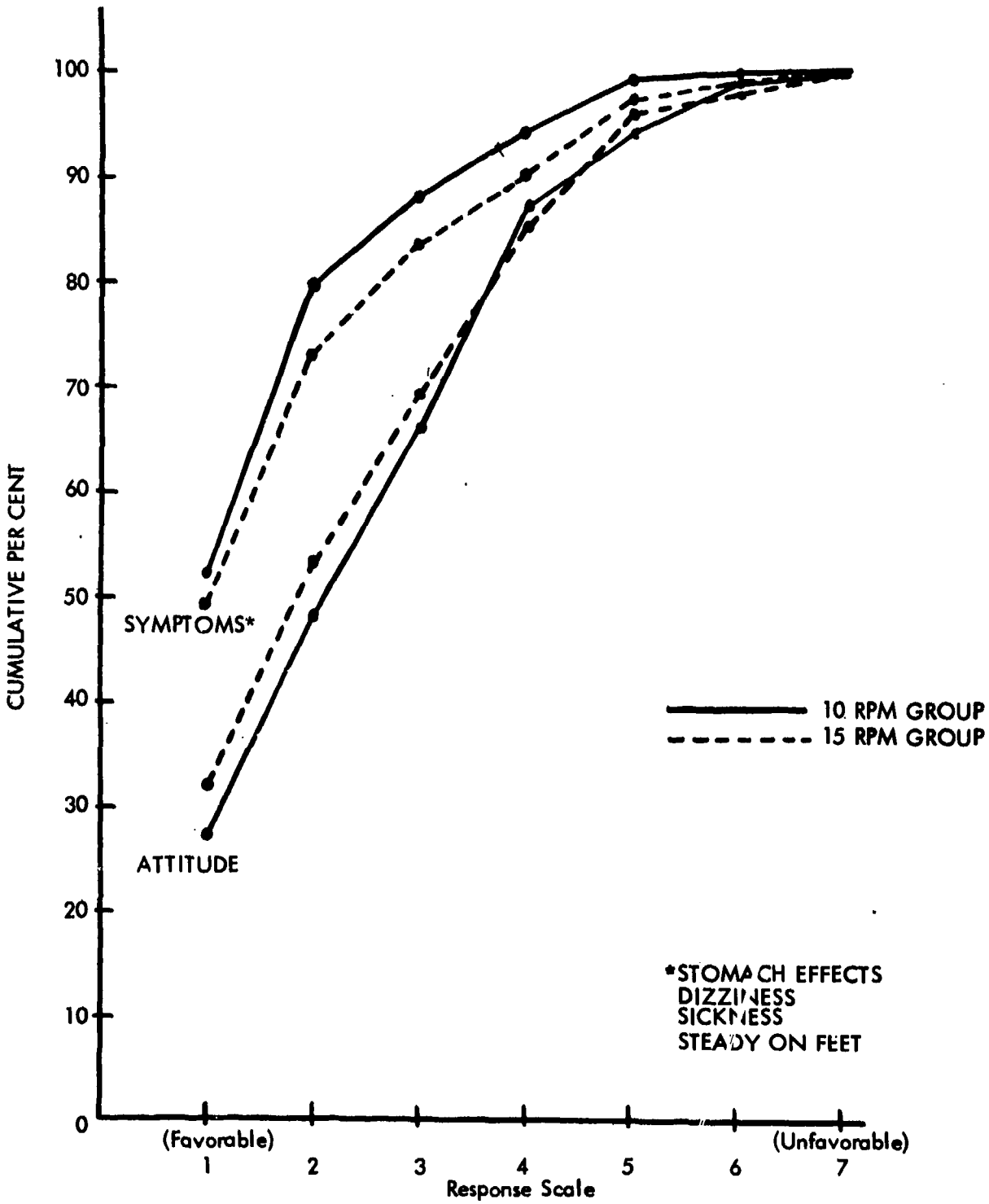

Figure 1
PATTERN OF SUBJECTIVE REPORTS OF SYMPTOMS AND ATTITUDE
ASSOCIATED WITH BVD AT 10 RPM AND 15 RPM

Table V

Separation Rates for Various BVDT Score Levels and Flight Aptitude Ratings

BVDT Scores	FAR 4 or 5		FAR 6 to 9	
	Input	% Separating	Input	% Separating
6.0 - 8.9	27	18.5	82	20.7
9.0 - 14.9	105	27.6	265	22.3
15.0 - 42.9	38	47.4	93	32.3
43.0 - or above	1	100.0	5	80.0
Total	171	31.0	445	24.7

It should be noted that data from all three samples were used to develop Table V and that the obtained surface was approximately the same for each sample examined separately; in other words, these data have been replicated.

CONCLUSIONS

On the basis of these results, it is concluded that the 10-rpm BVDT is a feasible procedure. It produced results nearly comparable to the 15-rpm procedure in regard to reliability and validity, while reducing the magnitude of disturbance to the test persons. Both procedures also significantly augmented the existing selection tests, and cost effectiveness was demonstrated.

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13. ABSTRACT

A Brief Vestibular Disorientation Test (BVDT) was developed that involves observer assessment of subjects' reactions produced by head movements in a rotating chair. Reliability of observers has been demonstrated, and significant validation and cross-validation coefficients have been reported for criteria of pass versus various types of separations from pilot training. It has also been established that the BVDT score significantly augmented the multiple correlation of existing aviation selection variables with the same criteria. The purpose of this study was to determine if reliability, validity, and augmentation of correlation could be obtained with less disturbance to the subject than that caused by the 15-rpm speed of rotation used thus far in the BVDT. Reduced disturbance and aftereffects are desired because the BVDT is now envisioned as becoming part of the entering flight physical, and procedures that might either impair performance on the other tests or require recovery periods must be held to a minimum. The BVDT procedure used here was identical to two previous studies except that a speed of 10-rpm was used instead of 15-rpm. Subjects were 157 flight students who were tested within the first four days of reporting for training. Retesting of 72 of the subjects was conducted 9 weeks later. The test-retest and rater reliability coefficients obtained were not quite so high as for those who had the 15-rpm procedure, but they were of acceptable magnitude. The validity coefficients were approximately the same as those obtained for 15-rpm, and significant augmentation of the existing selection battery and cost effectiveness was demonstrated. It was concluded, therefore, that the 10-rpm BVDT was a feasible procedure. It was also concluded that, because the mean score for the 10-rpm group was lower than the mean for either of the two 15-rpm groups used previously, subject disturbance had been reduced.

14. KEY WORDS	LINK A		LINK B		LINK C	
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Motion sickness						
Selection						
Vestibular mechanisms						